

WHAT IS CLAIMED IS

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1. An image forming method, comprising the steps of:

a) multi-level quantizing a multi-tone image by an error diffusion method; and

10 b) representing each pixel of the thus-quantized image having a quantized level higher than 0 using a dot which is larger as the quantized level thereof is higher,

15 wherein occurrence of dots having a specific size is repressed in a specific shade region relating to the dots.

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2. The method as claimed in claim 1, wherein occurrence of the smallest dots is repressed.

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3. The method as claimed in claim 1, wherein occurrence of the dots other than the largest dots is repressed.

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4. The method as claimed in claim 1, wherein an occurrence rate of the dots having the specific size is controlled based on the number of dots in a specific region in the periphery of a target pixel.

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5. The method as claimed in claim 1, wherein an occurrence rate of the dots having the specific size is controlled based on the number of dots in a specific region in the periphery of a target pixel and a shade level of the target pixel.

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6. The method as claimed in claim 1, wherein

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9. The method as claimed in claim 8, wherein occurrence of the dots having the specific size is repressed only for a picture region of the image.

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10. The method as claimed in claim 8, wherein the degree of repressing occurrence of the dots having the specific size is made weaker for a character region of the image than for a picture region of the image.

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11. The method as claimed in claim 8, wherein occurrence of the dots having the specific size is repressed only for a non-edge region of the image.

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12. The method as claimed in claim 1, wherein repressing of occurrence of the dots having the specific size is performed for a medium shade region of the image.

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b) repressing occurrence of one or more specific quantized levels for a specific level region of the image data relating to the one or more specific quantized levels.

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16. The method as claimed in claim 15,
wherein re-quantization is performed for the one or more
specific quantized levels, occurrence of which is to be
repressed.

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17. The method as claimed in claim 15,
10 wherein occurrence of the one or more specific quantized
levels is repressed for a medium level region of the
image data.

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18. The method as claimed in claim 15,
wherein occurrence of the one or more specific quantized
levels is repressed for a high level region of the image
20 data.

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19. The method as claimed in claim 15,

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wherein occurrence of the one or more specific quantized levels is repressed for medium and high level regions of the image data.

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20. The method as claimed in claim 15,
wherein an occurrence rate of the one or more specific
10 quantized levels, occurrence of which is to be repressed,
is controlled based on the number of pixels quantized to
quantized levels higher than 0 in a specific region in
the periphery of a target pixel.

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21. The method as claimed in claim 15,
wherein an occurrence rate of the one or more specific
20 quantized levels, occurrence of which is to be repressed,
is controlled based on the number of pixels quantized to
quantized levels higher than 0 in a specific region in
the periphery of a target pixel and the level of the
image data of the target pixel.

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22. The method as claimed in claim 15,
wherein an occurrence rate of the one or more specific
quantized levels, occurrence of which is to be repressed,
is controlled based on the number of pixels quantized to
5 a specific quantized level in a specific region in the
periphery of a target pixel.

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23. The method as claimed in claim 15,
wherein an occurrence rate of the one or more specific
quantized levels, occurrence of which is to be repressed,
is controlled based on the number of pixels quantized to
15 a specific quantized level in a specific region in the
periphery of a target pixel and the level of the image
data of the target pixel.

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24. The method as claimed in claim 15,
wherein a degree of repressing occurrence of the one or
more specific quantized levels is changed according to a
25 feature of the image.

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25. The method as claimed in claim 24,
wherein occurrence of the one or more specific quantized
levels is repressed only for a picture region of the
image.

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26. The method as claimed in claim 24,
10 wherein the degree of repressing occurrence of the one
or more specific quantized levels is made weaker for a
character region of the image than for a picture region
of the image.

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27. The method as claimed in claim 24,
wherein occurrence of the one or more specific quantized
20 levels is repressed only for a non-edge region of the
image.

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28. The method as claimed in claim 17,
wherein re-quantization is performed for the one or more
specific quantized levels, occurrence of which is to be
repressed.

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29. The method as claimed in claim 18,
10 wherein re-quantization is performed for the one or more
specific quantized levels, occurrence of which is to be
repressed.

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30. The method as claimed in claim 19,
wherein re-quantization is performed for the one or more
specific quantized levels, occurrence of which is to be
20 repressed.

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31. An image forming method comprising the

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steps of:

a) multi-level quantizing multi-tone image data by the image processing method as claimed in claim 15; and

5 b) forming an image from the thus-multi-level-quantized image data using dots for pixels which dots are larger as the pixels have higher quantized levels.

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32. An image forming method comprising the

steps of:

a) multi-level quantizing multi-tone image
15 data by the image processing method as claimed in claim
16; and

b) forming an image from the thus-multi-level-quantized image data using dots for pixels which dots are larger as the pixels have higher quantized levels.

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33. An image processing apparatus,

25 comprising:

a first part multi-level quantizing multi-level input image data; and

a second part repressing occurrence of one or more specific quantized levels for a specific level region of the image data relating to the one or more specific quantized levels.

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34. The apparatus as claimed in claim 33, wherein said second part performs re-quantization for the one or more specific quantized levels, occurrence of which is to be repressed.

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35. The apparatus as claimed in claim 33, wherein said second part represses occurrence of the one or more specific quantized levels for a medium level region of the image data.

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36. The apparatus as claimed in claim 33,
wherein said second part represses occurrence of the one
or more specific quantized levels for a high level
region of the image data.

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37. The apparatus as claimed in claim 33,
10 wherein said second part represses occurrence of the one
or more specific quantized levels for medium and high
level regions of the image data.

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38. The apparatus as claimed in claim 33,
wherein said second part controls occurrence rates of
the one or more specific quantized levels, occurrence of
20 which is to be repressed, based on the number of pixels
quantized to quantized levels higher than 0 in a
specific region in the periphery of a target pixel.

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39. The apparatus as claimed in claim 33,
wherein said second part controls occurrence rates of
the one or more specific quantized levels, occurrence of
which is to be repressed, based on the number of pixels
5 quantized to quantized levels higher than 0 in a
specific region in the periphery of a target pixel and
the level of the image data of the target pixel.

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40. The apparatus as claimed in claim 33,
wherein said second part controls occurrence rates of
the one or more specific quantized levels, occurrence of
15 which is to be repressed, based on the number of pixels
quantized to a specific quantized level in a specific
region in the periphery of a target pixel.

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41. The apparatus as claimed in claim 33,
wherein said second part controls occurrence rates of
the one or more specific quantized levels, occurrence of
25 which is to be repressed, based on the number of pixels

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44. The apparatus as claimed in claim 42,
25 wherein said second part makes the degrees of repressing

occurrence of the one or more specific quantized levels weaker for a character region of the image than for a picture region of the image.

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45. The apparatus as claimed in claim 42,
wherein said second part represses occurrence of the one
10 or more specific quantized levels only for a non-edge
region of the image.

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46. The apparatus as claimed in claim 33,
wherein said second part changes degrees of repressing
occurrence of the one or more specific quantized levels
according to a specified output mode.

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47. The apparatus as claimed in claim 35,
25 wherein said second part performs re-quantization for

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50. The apparatus as claimed in claim 38,
wherein said second part performs re-quantization for
the one or more specific quantized levels, occurrence of

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53. The apparatus as claimed in claim 41,
wherein said second part performs re-quantization for
the one or more specific quantized levels, occurrence of
which is to be repressed.

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20  data;
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for one or more specific quantized levels other than the highest quantized level and quantized level 0, as the need arises, and outputting the thus-obtained data as an output image data;

5 a fourth part obtaining the error to be added to the input image data, from the output image data and image data to which the error is already added by said first part, and providing the thus-obtained error to said first part; and

10 a fifth part detecting, from the output image data, the number of pixels quantized to be higher than the quantized level 0 in a specific region in the periphery of a target pixel, and providing the thus-obtained number to said third part,

15 wherein said third part compares a threshold, relating to each of said one or more specific quantized levels, determined based on the number provided by said fifth part, with the level of the image data to which the error is already added, and, thereby, determines
20 whether re-quantization for said each of said one or more specific quantized levels is necessary, occurrence of each of said one or more specific quantized levels being repressed in a specific level region of the input image data relating to said each of said one or more
25 specific quantized levels through the re-quantization by

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data;
20 a second part multi-level quantizing the image
data to which the error is already added by said first
part, using a plurality of quantization thresholds;

25 a third part re-quantizing the quantized data provided by said second part, into another quantized level, for one or more specific quantized levels other

than the highest quantized level and quantized level 0,
as the need arises, and outputting the thus-obtained
data as output image data;

5 a fourth part obtaining the error to be added
to the input image data, from the output image data and
image data to which the error is already added by said
first part, and providing the thus-obtained error to
said first part; and

10 a fifth part detecting, from the output image
data, the number of pixels quantized to be higher than
the quantized level 0 in a specific region in the
periphery of a target pixel, and providing the thus-
obtained number to said third part,

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15 wherein said third part compares a threshold,
relating to each of said one or more specific quantized
levels, determined based on the number provided by said
fifth part and the level of the input image data, with
the level of the image data to which the error is
already added, and, thereby, determines whether re-
20 quantization for said each of said one or more specific
quantized levels is necessary, occurrence of each of
said one or more specific quantized levels being
repressed in a specific level region of the input image
data relating to said each of said one or more specific
25 quantized levels through the re-quantization by said

third part.

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59. An image processing apparatus,
comprising:

a first part adding an error to input image
data;

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a second part multi-level quantizing the image
data to which the error is already added by said first
part, using a plurality of quantization thresholds;

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a third part re-quantizing the quantized data
provided by said second part, into another quantized
level, for one or more specific quantized levels other
than the highest quantized level and quantized level 0,
as the need arises, and outputting the thus-obtained
data as an output image data;

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a fourth part obtaining the error to be added
to the input image data, from the output image data and
image data to which the error is already added by said
first part, and providing the thus-obtained error to
said first part; and

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a fifth part detecting, from the output image
data, the number of pixels for each quantized level in a

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specific region in the periphery of a target pixel, and
providing the thus-obtained number to said third part,

wherein said third part compares a threshold,
relating to each of said one or more specific quantized
5 levels, determined based on the total number of pixels
of each of said one or more specific quantized levels
and one or more other quantized levels near to said each
of the one or more specific quantized levels and the
level of the input image data, with the level of the
10 image data to which the error is already added, and,
thereby, determines whether re-quantization for said
each of said one or more specific quantized levels is
necessary, occurrence of each of said one or more
specific quantized levels being repressed in a specific
15 level region of the input image data relating to said
each of said one or more specific quantized levels
through the re-quantization by said third part.

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60. An image processing apparatus,

comprising:

a first part adding an error to input image

25 data;

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a second part multi-level quantizing the image data to which the error is already added by said first part, using a plurality of quantization thresholds;

5 a third part re-quantizing the quantized data provided by said second part, into another quantized level, for one or more specific quantized levels, as the need arises, and outputting the thus-obtained data as output image data;

10 a fourth part obtaining the error to be added to the input image data, from the output image data and image data to which the error is already added by said first part, and providing the thus-obtained error to said first part; and

15 a fifth part detecting, from the output image data, the number of pixels quantized to be higher than the quantized level 0 in a specific region in the periphery of a target pixel, and providing the thus-obtained number to said third part,

20 wherein said third part has a signal indicating a feature of an image region to which the target pixel belongs input thereto from the outside, and compares a threshold, relating to each of said one or more specific quantized levels, determined based on a parameter relating to said each of said one or more
25 specific quantized levels determined according to the

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feature indicated by said signal, the number provided by
said fifth part and the level of the input image data,
with the level of the image data to which the error is
already added, and, thereby, determines whether re-
5 quantization for said each of said one or more specific
quantized levels is necessary, occurrence of each of
said one or more specific quantized levels being
repressed in a degree according to said feature in a
specific level region of the input image data relating
10 to said each of said one or more specific quantized
levels through the re-quantization by said third part.

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61. The image processing apparatus as claimed
in claim 60, wherein:

said signal indicates whether the image region
to which the target pixel belongs is a character region
20 or a picture region; and

said parameter relating to each of said one or
more specific quantized levels is determined such that
occurrence of said each of said one or more specific
quantized levels is repressed only for the picture
25 region.

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62. The image processing apparatus as claimed
in claim 60, wherein:

said signal indicates whether the image region
to which the target pixel belongs is a character region
5 or a picture region; and

said parameter relating to each of the one or
more specific quantized levels is determined such that
the degree of repressing occurrence of said each of said
one or more specific quantized levels is made weaker for
10 the character region than for the picture region.

63. The image processing apparatus as claimed
15 in claim 60, wherein:

said signal indicates whether the image region
to which the target pixel belongs is an edge region or a
non-edge region; and

20 said parameter relating to each of the one or
more specific quantized levels is determined such that
occurrence of said each of said one or more specific
quantized levels is repressed only for the non-edge
region

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64. An image processing apparatus,
comprising:

a first part adding an error to input image
data;

5 a second part multi-level quantizing the image
data to which the error is already added by said first
part, using a plurality of quantization thresholds;

a third part re-quantizing the quantized data
provided by said second part, into another quantized
10 level, for one or more specific quantized levels, as the
need arises, and outputting the thus-obtained data as an
output image data;

a fourth part obtaining the error to be added
to the input image data, from the output image data and
15 image data to which the error is already added by said
first part, and providing the thus-obtained error to
said first part; and

a fifth part detecting, from the output image
data, the number of pixels quantized to be higher than
20 the quantized level 0 in a specific region in the
periphery of a target pixel, and providing the thus-
obtained number to said third part,

wherein said third part has a signal
indicating an output mode input thereto from the outside,
25 and compares a threshold, relating to each of said one

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or more specific quantized levels, determined based on a
parameter relating to said each of said one or more
specific quantized levels determined according to the
output mode indicated by said signal, the number
5 provided by said fifth part and the level of the input
image data, with the level of the image data to which
the error is already added, and, thereby, determines
whether re-quantization for said each of said one or
more specific quantized levels is necessary, occurrence
10 of each of said one or more specific quantized levels
being repressed in a degree according to said output
mode in a specific level region of the input image data
relating to said each of said one or more specific
quantized levels through the re-quantization by said
15 third part.

65. The image processing apparatus as claimed
20 in claim 56, wherein:

said second part performs 4-level
quantization;

the re-quantization performed by said third
part is performed for the quantized level 1; and
25 occurrence of the quantized level 1 is

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67. The image processing apparatus as claimed
in claim 59, wherein:
said second part performs 4-level
quantization;
the re-quantization performed by said third
part is performed for the quantized level 1; and
occurrence of the quantized level 1 is

repressed in a medium level region of the input image data.

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68. The image processing apparatus as claimed in claim 60, wherein:

10 said second part performs 4-level quantization;
 the re-quantization performed by said third part is performed for the quantized level 1; and
 occurrence of the quantized level 1 is repressed in a medium level region of the input image
15 data.

69. The image processing apparatus as claimed in claim 64, wherein:

20 said second part performs 4-level quantization;
 the re-quantization performed by said third part is performed for the quantized level 1; and
25 occurrence of the quantized level 1 is

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10 said second part performs 4-level
quantization;

occurrence of the quantized level 1 is
15 repressed in a medium level region of the input image
data; and

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25 said second part performs 4-level

quantization;

the re-quantization performed by said third part is performed for the quantized level 1 and quantized level 2;

5 occurrence of the quantized level 1 is repressed in a medium level region of the input image data; and

occurrence of the quantized level 2 is repressed in a high level region of the input image data.

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72. The image processing apparatus as claimed in claim 59, wherein:

15 said second part performs 4-level quantization;

the re-quantization performed by said third part is performed for the quantized level 1 and quantized level 2;

20 occurrence of the quantized level 1 is repressed in a medium level region of the input image data; and

occurrence of the quantized level 2 is repressed in a high level region of the input image data.

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said second part performs 4-level
quantization;

occurrence of the quantized level 1 is repressed in a medium level region of the input image

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said second part performs 4-level

the re-quantization performed by said third part is performed for the quantized level 1 and quantized level 2;

occurrence of the quantized level 1 is
25 repressed in a medium level region of the input image

data; and

occurrence of the quantized level 2 is
repressed in a high level region of the input image data.

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75. The image processing apparatus as claimed
in claim 60, further comprising a sixth part generating
10 said signal input to said third part.

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76. The image processing apparatus as claimed
in claim 56, further comprising a sixth part which forms
an image from the image output data, using dots for
pixels which dots are larger as the pixels have higher
quantized levels.

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77. The image processing apparatus as claimed
25 in claim 58, further comprising a sixth part which forms

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80. The image processing apparatus as claimed
in claim 64, further comprising a sixth part which forms
an image, from the image output data, using dots for
pixels which dots are larger as the pixels have higher
5 quantized levels.

10 81. The image processing apparatus as claimed
in claim 56, further comprising a sixth part generating
the input image data by optically scanning an original.

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82. The image processing apparatus as claimed
in claim 58, further comprising a sixth part generating
the input image data by optically scanning an original.

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83. The image processing apparatus as claimed
25 in claim 59, further comprising a sixth part generating

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the input image data by optically scanning an original.

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84. The image processing apparatus as claimed in claim 60, further comprising a sixth part generating the input image data by optically scanning an original.

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85. The image processing apparatus as claimed in claim 64, further comprising a sixth part generating the input image data by optically scanning an original.

86. The image processing apparatus as claimed in claim 56, further comprising:

a sixth part generating the input image data by optically scanning an original; and

a seventh part forming an image, from the image output data, using dots for pixels which dots are larger as the pixels have higher quantized levels.

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87. The image processing apparatus as claimed in claim 58, further comprising:

a sixth part generating the input image data by optically scanning an original; and

5 a seventh part forming an image, from the image output data, using dots for pixels which dots are larger as the pixels have higher quantized levels.

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88. The image processing apparatus as claimed in claim 59, further comprising:

15 a sixth part generating the input image data by optically scanning an original; and

a seventh part forming an image, from the image output data, using dots for pixels which dots are larger as the pixels have higher quantized levels.

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89. The image processing apparatus as claimed in claim 60, further comprising:

25 a sixth part generating the input image data

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by optically scanning an original; and

a seventh part forming an image, from the image output data, using dots for pixels which dots are larger as the pixels have higher quantized levels.

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90. The image processing apparatus as claimed
10 in claim 64, further comprising:

a sixth part generating the input image data by optically scanning an original; and

a seventh part forming an image, from the image output data, using dots for pixels which dots are
15 larger as the pixels have higher quantized levels.

20 91. A computer-readable recording medium storing therein a program for causing a computer to carry out the function of each part of the image processing apparatus as claimed in claim 56.

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95. A computer-readable recording medium

storing therein a program for causing a computer to
carry out the function of each part of the image
processing apparatus as claimed in claim 64.

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